Preview of Award 0546423 - Final Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	**4900**
Federal Grant or Other Identifying Number Assigned by Agency:	**0546423**
Project Title:	**CAREER: The Evolution of Simple Versus Complex Biomechanical Systems**
PD/PI Name:	**Jeffrey T Streelman, 000232909**
Submitting Official:	**Jeffrey T Streelman** **Principal Investigator**
Submission Date:	**5/6/2013**
Recipient Organization:	**Georgia Tech Research Corporation**
Project/Grant Period:	**2/1/2006 - 1/31/2013**
Reporting Period:	**2/1/2012 - 1/31/2013**
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions):	**Jeffrey T Streelman**

Accomplishments

What are the major goals of the project?

This is the final report for IOS 0546423, covering the project period 02/2012 - 01/2013.
During this final year of the project, we published two papers contributing to the major scientific goal of this project, to understand the genetic basis of complex versus simple systems in the oral jaws of cichlid fishes.
The citations are here (abstracts pasted below):
2013 Parnell, N.F. and J.T. Streelman. Genetic interactions controlling sex and color establish the potential for sexual conflict in Lake Malawi cichlid fishes. Heredity 110: 239-246. http://www.ncbi.nlm.nih.gov/pubmed/23092997.
2012 Parnell, N.F., C.D. Hulsey and J.T. Streelman. The genetic basis of a complex functional system. Evolution 66: 3352-3366. Online Open. http://www.ncbi.nlm.nih.gov/pubmed/23106702.
We continued to work with area elementary schools, to use cichlid fish diversity to help young learners understand ecology, form and function. As a major milestone from this year, we worked with Georgia Tech's OIT to purchase and install a video-conferencing unit at Morningside Elementary School (Atlanta Public Schools) and have worked with fourth grade teachers there to establish a set of 'expert' real-time interviews between 4th grade classrooms and scientists at Tech.

What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Significant Results:

The major results from this year are reported in two publications, in the journals Heredity and Evolution. I reprint the abstracts here:
2013 Parnell, N.F. and J.T. Streelman. Genetic interactions controlling sex and color establish the potential for sexual conflict in Lake Malawi cichlid fishes. Heredity 110: 239-246. http://www.ncbi.nlm.nih.gov/pubmed/23092997.
Sex-determining systems may evolve rapidly and contribute to lineage diversification. In fact, recent work has suggested an integral role of sex chromosome evolution in models of speciation. We use QTL analysis of RAD-tag SNPs to identify multiple loci responsible for sex determination and reproductively adaptive color phenotypes in Lake Malawi cichlids. We detect a complex epistatic sex system consisting of a major female heterogametic ZW locus on chromosome 5, two separate male heterogametic XY loci on chromosome 7, and two additional interacting loci on chromosomes 3 and 20. Our data support the known chromosomal linkage between orange blotch color and ZW, as well as novel genetic associations between male blue nuptial color and two sex determining regions (an XY and ZW locus). These results provide further empirical evidence for a complex antagonistic sex-color system in this species flock and suggest a possible role for, and effect of, polygenic sex-determining systems in rapid evolutionary diversification.
2012 Parnell, N.F., C.D. Hulsey and J.T. Streelman. The genetic basis of a complex functional system. Evolution 66: 3352-3366. Online Open. http://www.ncbi.nlm.nih.gov/pubmed/23106702.

The relationship between form and function can have profound effects on evolutionary dynamics and such effects may differ for simple versus complex systems. In particular, functions produced by multiple structural configurations (many-to-one mapping, MTOM) may dampen constituent trade-offs and promote diversification. Unfortunately, we lack information about the genetic architecture of MTOM functional systems. The skulls of teleost fishes contain both simple (lower jaw levers) as well as more complex (jaws modeled as 4-bar linkages) functional systems within the same craniofacial unit. We examined the mapping of form to function and the genetic basis of these systems by identifying quantitative trait loci in hybrids of two Lake Malawi cichlid species. Hybrid individuals exhibited novelty (transgressive segregation) in morphological components and function of the simple and complex jaw systems. Functional novelty was proportional to the prevalence of extreme morphologies in the simple levers; by contrast, recombination of parental morphologies produced transgression in the MTOM 4-bar linkage. We found multiple loci of moderate effect and epistasis controlling jaw phenotypes in both the simple and complex systems, with less phenotypic variance explained by QTL for the 4-bar. Genetic linkage between components of the simple and complex systems partly explains phenotypic correlations and may constrain functional evolution.
In addition to these publications from Streelman's lab, the award also supported an independent publication from Darrin Hulsey, a former postdoc in Streelman's lab, presently Assistant Professor at University of Tennessee. The citation is:
2013 Hulsey, C.D., B.P. Keck, H. Alamillo and B.C. O'Meara. Mitochondrial genome primers for Lake Malawi cichlids. Molecular Ecol. Res. 13: 347-353.
Two final manuscripts from the project are in review or in preparation, respectively. Each of these considers the rate of locomotory and trophic evolution in the cichlid flock of Lake Malawi, respectively.

What opportunities for training and professional development has the project provided?

During this final year of the project, the main person trained by the award was Nicholas Parnell, a postdoc in Streelman's group. Parnell published two papers this year, and a total of 5 over the period of support. Parnell's goal is to be a professor at a US college or university.

How have the results been disseminated to communities of interest?

Nothing to Report

What do you plan to do during the next reporting period to accomplish the goals?

Uploaded Files

See supporting files:

None reported

Products

Journals

Journal 1 of 2

Genetic interactions controlling sex and color establish the potential for sexual conflict in Lake Malawi cichlid fishes	
Journal:	HEREDITY
Issue:	3
Volume:	110
Publication Date:	3/1/2013
Page Numbers:	239-246
Authors:	Parnell, N. F.; Streelman, J. T.

Publication Status:	Published
Peer Reviewed:	
Acknowledgement of Federal Support:	Yes

Journal 2 of 2

THE GENETIC BASIS OF A COMPLEX FUNCTIONAL SYSTEM	
Journal:	EVOLUTION
Issue:	11
Volume:	66
Publication Date:	11/1/2012
Page Numbers:	3352-3366
Authors:	Parnell, Nicholas F.; Hulsey, C. Darrin; Streelman, J. Todd
Publication Status:	Published
Peer Reviewed:	
Acknowledgement of Federal Support:	Yes

Uploaded Files

See supporting files:

None reported

Participants

Research Experience for Undergraduates (REU) funding

What individuals have worked on the project?

Name	Most Senior Project Role	Email Address	Nearest Person Month Worked
NIcholas Parnell	Postdoctoral	nicholas.parnell@biology.gatech.edu	6
Jeffrey T Streelman	PD/PI	todd.streelman@biology.gatech.edu	2

Participant 1 of 2

NIcholas Parnell , nicholas.parnell@biology.gatech.edu	
Nearest Persons Months Worked:	6
Funding Support:	NA

International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	
REU: Government Fiscal Year(s) Participant was Supported:	
Contribution: This past year, NIcholas analyzed genetic data and was the first author on two manuscripts reporting QTL for jaw function and sex determination/nuptial color, respectively.	

Participant 2 of 2

Jeffrey T Streelman , todd.streelman@biology.gatech.edu	
Nearest Persons Months Worked:	2
Funding Support:	NA
International Country(ies) of Collaboration:	N/A
Foreign Travel:	N/A
REU: Year of Schooling Completed:	
REU: Home Institution:	
REU: Government Fiscal Year(s) Participant was Supported:	
Contribution: Streelman is PI	

What other organizations have been involved as partners?

Nothing to Report

Have other collaborators or contacts been involved? NO

Impacts

What is the impact on the development of the principal discipline(s) of the project?

This year's contributions to the field of evolutionary biology include:
1. one of the first implementations of RAD-Tag SNP QTL mapping for an evolutionary model organism (Heredity and Evolution papers).
2. first demonstration that the genetic basis of complex jaw function can be approached by mapping the genetic basis of constituent parts.
3. a direct comparision of the genetic basis of simple verus complex biomechanical systems in the same jaw.

What is the impact on other disciplines?

Our paper in Evolution describes the genetic basis of a complex biomechanical system characterized by "many-to-one-mapping" of form to function, a common theme amongst functional biologists, physiologists, evolutionary biologists, biomechanicians, etc. Ours was the first attempt to characterize the genetic basis of a system exhibiting MTOM.

What is the impact on the development of human resources?

Postdoc Parnell was able to gain additional training and experience as he seeks a job as professor at a US college or university.

What is the impact on physical resources that form infrastructure?

Nothing to Report

What is the impact on institutional resources that form infrastructure?

Nothing to Report

What is the impact on information resources that form infrastructure?

Streelman has established an information conduit between Georgia Tech and area elementary schools, useful now for delivery of expert lectures from Streelman and many other professors at Georgia Tech.

What is the impact on technology transfer?

Nothing to Report

What is the impact on society beyond science and technology?

Nothing to Report

Changes

Changes in approach and reasons for change

Nothing to Report

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to Report

Changes that have a significant impact on expenditures

Nothing to Report

Significant changes in use or care of human subjects

Nothing to Report

Significant changes in use or care of vertebrate animals

Nothing to Report

Significant changes in use or care of biohazards

Nothing to Report

Special Requirements

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements

Nothing to Report

Uploaded Files

See supporting files:

None reported